

1 WHAT IS CLAIMED IS:

2 1. A system for dynamically routing a message over a network having a plurality
3 of nodes, the system comprising:
4 a publisher for generating and sending the message on a topic, the publisher
5 having an output;
6 a plurality of subscribers each having an input for receiving the message, each of
7 the plurality of subscribers subscribing to the topic; and
8 a broker having an input, an output and a topic/node table, the broker routing the
9 message to the plurality of subscribers in response to receipt of the
10 message, the broker determining which of the plurality of nodes to which
11 to send the message for delivery to the plurality of subscribers, the input of
12 the broker coupled to the output of the publisher, and output of the broker
13 coupled to the inputs of the plurality of subscribers.

1 2. The system of claim 1 wherein the publisher is a client application program.

1 3. The system of claim 1 wherein the subscriber is a client application program.

1 4. The system of claim 1 wherein the broker further comprises a message queue
2 for storing messages received from the publisher.

1 5. The system of claim 1 wherein the broker further comprises a dead message
2 queue for storing messages determined by the broker to be undeliverable.

1 6. The system of claim 1 further comprising a topic/node table, the topic/node
2 table used by the broker to determine which of the plurality of nodes to which to send the
3 message for delivery to the plurality of subscribers.

1 7. The system of claim 6 wherein the topic/node table is capable of storing a
2 topic and a subtopic for a subscriber or broker.

1 8. The system of claim 1 further comprising:
2 a second broker having an input and an output, the second broker routing the
3 message to the plurality of subscribers in response to receipt of the
4 message, the second broker communicatively coupled to the first broker;
5 and
6 a cluster topic/node table, the cluster topic/node table used by the broker and the
7 second broker to determine which of the plurality of nodes to which to
8 send the message for delivery to the plurality of subscribers.

1 9. The system of claim 1 wherein the broker further comprises a subscribing
2 module for establishing a subscription to the topic by a new subscriber, the subscribing
3 module coupled for communication with a new subscriber, the subscribing module
4 updating the topic/node table with the new subscriber.

1 10. The system of claim 1 wherein the broker further comprises a publishing
2 module, the publishing module coupled to the topic/node table, the publishing module
3 determining the subscribers for the topic and a path to the subscribers, the publishing
4 module sending the message to the subscribers over the determined path.

1 11. The system of claim 1 wherein the broker further comprises a forwarding
2 module having an input and an output for routing messages to in response to receipt of
3 the message from another broker, the forwarding module determining which of the
4 plurality of nodes to which to send the message for delivery to the plurality of
5 subscribers, the input of the forwarding module coupled to receive messages from the
6 other broker, the output of the forwarding module coupled to the inputs of the plurality of
7 subscribers.

1 12. The system of claim 1 further comprising a path selection module coupled to
2 the broker, the path selection module for identifying at least one path through the
3 plurality of nodes from the broker to one subscriber, the path selection module providing
4 the identified path to the broker for routing of the message over the identified paths.

1 13. The system of claim 12 wherein the path selection module provide real-time
2 adjustment of the path identified by monitoring the connections between the plurality of
3 nodes and recalculating the best path.

1 14. The system of claim 1 further comprising a traffic control module for
2 controlling message traffic over the plurality of nodes, the traffic control module
3 monitoring connections between the plurality of nodes for changes in bandwidth and re-
4 routing topics according to bandwidth preferences.

1 15. The system of claim 1 further comprising a delivery control module for
2 eliminating duplicate messages, the delivery control module coupled to the broker to
3 receive messages.

1 16. The system of claim 1 further comprising a delivery control module for
2 filtering messages, the deliver control module coupled to the broker to receive and send
3 messages, the deliver control module comparing a selector to message received from the
4 broker and dropping the message if it does not match the selector.

1 17. The system of claim 1 further comprising a direct publishing module having
2 an input and the output for publishing a message directly to a cluster, the direct
3 publishing module coupled to the broker, direct publishing module receiving a cluster
4 identification, determining a path to the cluster and send the message to the cluster.

1 18. A method for publishing a message in a publish/subscribe architecture having
2 at least one publisher, a plurality of subscribers, and plurality of brokers, the method
3 comprising the steps of:
4 receiving the message and a topic at a broker;

5 identifying one or more subscribers for the topic received;
6 determining a path for sending the message; and
7 sending the message to the identified subscribers.

1 19. The method of claim 18, wherein the message is generated and assigned a
2 topic by a client application program and the message and topic are sent by the client
3 application program to the broker.

1 20. The method of claim 18, wherein the step of identifying one or more
2 subscribers is performed by comparing the topic to names in a topic/node table.

1 21. The method of claim 18, further comprising the step of examining the
2 message for delivery controls.

1 22. The method of claim 21, wherein the step of examining the message for
2 delivery controls, further comprises the step of determining whether the message is a
3 duplicate, and deleting the message if it is a duplicate.

1 23. The method of claim 21, wherein the step of examining the message for
2 delivery controls, further comprises the step of determining whether the broker has
3 permission to publish the message.

1 24. The method of claim 21, wherein the step of examining the message for
2 delivery controls, further comprises the steps of:

3 determining whether a routing queue can store the message;
4 determining whether buffers of the subscribers can store the message; and
5 wherein the step of sending the message is performed only if the routing queue
6 can store the message and the buffers of the subscribers can store the
7 message.

1 25. The method of claim 24, wherein the step of examining the message for
2 delivery controls, further comprises the step of invoking flow control handling if the
3 routing queue cannot store the message or the buffers of the subscribers cannot store the
4 message.

1 26. The method of claim 21, wherein the step of examining the message for
2 delivery controls, further comprises the steps of:
3 determining whether there is a selector active;
4 if there is a selector active, comparing the selector to the message for a match; and
5 wherein the step of sending the message is performed only if the selector matches
6 the message.

1 27. The method of claim 18, wherein the step of determining the path for sending
2 the message, further comprises the steps of:
3 determining a plurality of paths from the broker to the subscribers; and
4 selecting the best path for sending the message.

1 28. The method of claim 27, wherein the step of selecting the best path for
2 sending the message use one criterion from the group of: paths that have the fewest nodes
3 to traverse, paths that are the shortest in distance, paths that are the fastest, paths with the
4 least traffic, paths with the most available bandwidth, paths that have the fewest
5 bottlenecks, and paths with best routing conditions.

1 29. The method of claim 18, wherein the step of determining the path for sending
2 the message further comprises the step of performing real-time adjustment of the path.

1 30. The method of claim 29, wherein the step of performing real-time adjustment
2 of the path further comprises the steps of:
3 monitoring connection between nodes;
4 determining whether any connections are not available; and
5 recalculating a best path for any subscribers affected by an unavailable
6 connection.

1 31. The method of claim 18, wherein the step of determining the path for sending
2 the message further comprises the steps of:
3 determining whether strict message ordering has been selected; and
4 ensuring ordered delivery of messages if strict message ordering has been
5 selected.

1 32. The method of claim 31, wherein the step of ensuring further comprises using
2 a single path for message delivery.

1 33. The method of claim 31, wherein the step of ensuring further comprises
2 adding an order number to each message sent, and ordering the message according to the
3 order number at the subscriber before presentation.

1 34. The method of claim 18, wherein the step of determining the path for sending
2 the message further comprises the step of determining multiple paths to deliver the
3 message from the broker to the subscriber.

1 35. The method of claim 34, wherein the step of determining multiple paths
2 further comprises the steps of:
3 monitoring bandwidth connections between nodes;
4 calculating an alternate path for sending messages from the broker to the
5 subscriber for path using nodes with diminished bandwidth; and
6 sending message on the alternate path.

1 36. The method of claim 35, wherein the step of calculating and sending the
2 message on the alternate path are performed only if more bandwidth is needed for a
3 subscriber.

1 37. The method of claim 18, further comprising the steps of:

2 determining whether there are any local subscriber for the topic; and
3 sending the message directly from the broker to the local subscribers.

1 38. The method of claim 18, further comprising the steps of:
2 identifying a cluster to which to send the message;
3 wherein step of determining a path for sending the message, determines a best
4 path for sending the message to the identified cluster; and
5 wherein the step of sending the message is performed by sending the message to
6 the identified cluster using the best path for sending the message to the
7 identified cluster.

1 39. A method for forwarding a message in a publish/subscribe architecture
2 having at least one publisher, a plurality of subscribers, and plurality of brokers, the
3 method comprising the steps of:
4 receiving the message and a topic at a second broker from a first broker;
5 determining subscribers local to the second broker that subscribe to the topic;
6 sending the message from the second broker to the local subscribers;
7 identifying one or more additional brokers for the topic received;
8 determining a path for sending the message to the additional brokers; and
9 sending the message to the additional brokers.

1 40. The method of claim 39, further comprising the steps of:
2 determining subscribers local to the second broker that subscribe to the topic; and
3 sending the message from the second broker to the local subscribers.

1 41. The method of claim 39, further comprising the step of eliminating a path that
2 the message was received on from the paths for sending the message to the additional
3 brokers.

1 42. The method of claim 39, further comprising the step of eliminating a path that
2 the message was received on from the paths for sending the message to the additional
3 brokers.

1 43. The method of claim 39, further comprising the step of examining the
2 message for delivery controls.

1 44. The method of claim 39, wherein the step of determining the path for sending
2 the message, further comprises the steps of:
3 determining a plurality of paths from the broker to the subscribers; and
4 selecting the best path for sending the message.

1 45. The method of claim 44, wherein the step of selecting the best path for
2 sending the message use one criterion from the group of: paths that have the fewest nodes
3 to traverse, paths that are the shortest in distance, paths that are the fastest, paths with the
4 least traffic, paths with the most available bandwidth, paths that have the fewest
5 bottlenecks, and paths with best routing conditions.

1 46. The method of claim 39, wherein the step of determining the path for sending
2 the message further comprises the step of performing real-time adjustment of the path.

1 47. The method of claim 39, wherein the step of determining the path for sending
2 the message further comprises the steps of:

3 determining whether strict message ordering has been selected; and
4 ensuring ordered delivery of messages if strict message ordering has been
5 selected.

1 48. The method of claim 39, wherein the step of determining the path for sending
2 the message further comprises the step of determining multiple paths to deliver the
3 message from the broker to the subscriber.

1 49. A method for establishing a subscription to a topic in a publish/subscribe
2 architecture having at least one publisher, a plurality of subscribers, and plurality of
3 brokers, the method comprising the steps of:
4 receiving a subscription request for a topic at a first broker;
5 updating a broker topic/node table for the first broker;
6 determining whether propagation of the subscription is required; and
7 propagating the subscription to a second broker if propagation of the subscription
8 is required.

1 50. The method of claim 49, further comprising the step of consolidating the
2 subscription before the step of propagating the subscription.

1 51. The method of claim 49, wherein the step of determining whether
2 propagation of the subscription is required further comprises the step of determining
3 whether there is already a subscriber at the first broker subscribing to the topic

1 52. The method of claim 49, wherein the step of determining whether
2 propagation of the subscription is required further comprises the steps of;
3 comparing the received subscription request to existing subscriptions for the first
4 broker; and
5 requiring propagation of the subscription if the received subscription request has
6 any parameters that are different from existing subscriptions.

1 53. The method of claim 49, wherein the step of propagating the subscription to a
2 second broker further comprises:
3 sending an updated subscription to the second broker;
4 comparing by the second broker its security policy to the updated subscription;
5 and
6 accepting or rejecting by the second broker the subscription.

1 54. A method for automatically terminating a subscription to a topic in a
2 publish/subscribe architecture having at least one publisher, a plurality of subscribers,
3 and plurality of brokers, the method comprising the steps of:
4 selecting a subscriber;
5 determining whether a node corresponding to the selected subscriber is in
6 accessible; and
7 if the node has been inaccessible for a predetermined amount of time, removing
8 the subscription corresponding to the subscriber.

1 55. The method of claim 54, wherein the step of removing the subscription
2 further comprises the step of storing messages received for the subscription in a dead
3 message queue.

1 56. The method of claim 54, wherein the step of removing the subscription
2 further comprises the step of propagating the subscription removal to at least one other
3 node.

1 57. The method of claim 54, further comprising the steps of:
2 determining the number of messages in a routing queue for the selected
3 subscriber, and
4 if the number of messages in a routing queue for the selected subscriber is above a
5 predefined threshold, removing the subscription corresponding to the subscriber.

1 58. The method of claim 54, wherein the steps of selecting, determining,
2 removing are preformed for additional nodes in the publish/subscribe architecture.

1 59. A method for delivering message to a durable subscriber in a
2 publish/subscribe architecture having at least one publisher, a plurality of subscribers,
3 and plurality of brokers, the method comprising the steps of:
4 receiving a message for a subscriber at a node in the publish/subscribe
5 architecture;
6 determining whether the subscriber is a durable subscriber;
7 determining whether the subscriber is accessible;
8 storing the message if the subscriber is not accessible; and
9 delivering the message if the subscriber is available.

1 60. The method of claim 59, wherein the message is stored in non-volatile
2 memory.

1 61. The method of claim 59, wherein the message is dropped if the subscriber is
2 not durable and the subscriber is not accessible.

1 62. A method for controlling traffic in a publish/subscribe architecture having at
2 least one publisher, a plurality of subscribers, and plurality of nodes, the method
3 comprising the steps of:
4 monitoring bandwidth over connections between nodes;
5 identifying a connection with decreasing bandwidth;
6 identifying a topic using an identified connection;
7 determining any bandwidth preferences between topics; and
8 re-routing a topic according to a bandwidth preference.